Grating Visual Acuity Using the Preferential-Looking Method in Elderly Nursing Home Residents

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PURPOSE. To assess the performance of two approaches to visual acuity testing in a group of nursing home residents with cognitive impairment. The study was a cross-sectional comparison of the effectiveness of two tests of visual acuity.

METHODS. Nursing home residents participating in a clinical trial were tested with both recognition acuity charts and gratings acuity cards (Teller) by masked observers.

RESULTS. Of the nursing home residents (n = 656) who participated in the study, 86% could respond to visual acuity testing in at least one eye. Eighty-four percent were testable using Teller cards versus 73% who were testable by Early-Treatment Diabetic Retinopathy Study (ETDRS) charts or Lea symbol charts. Forty-one percent of individuals with MiniMental Status Examination (MMSE) scores lower than 10 were testable by recognition acuity, whereas 61% were testable with grating acuity. Grating acuity correlated well with recognition acuity (R = 0.79; 95% CI, 0.75–0.98, intraclass correlation coefficient [ICC]). The correlation was slightly lower in individuals with decreased MMSE scores. Although grating acuity was one line better than recognition acuity on average and median acuities were the same, 24% of individuals had results that differed by three or more lines.

CONCLUSIONS. Teller acuity cards can effectively test the vision in cognitively impaired individuals who are not testable by conventional means. Grating acuity results correlated well with those of recognition acuity, although differences of three or more lines were not uncommon. Wider use of grating acuity testing allows a more complete assessment of visual function in the cognitively impaired elderly. (Invest Ophthalmol Vis Sci. 2002;43:2572–2578)

Testing vision in cognitively impaired elderly people remains a challenging task. Individuals with moderate-to-severe dementia frequently cannot concentrate long enough to recognize characters on standard visual acuity charts, or they do not have the ability to communicate clearly when they see presented targets. These limitations can cause vision-threatening conditions to be missed in individuals with dementia. Screening programs intended to identify eye disease in this population face tremendous logistic difficulties, because many cannot be tested by conventional means, or the results suggest impairment when it is likely that poor performance or lapsing concentration is the underlying cause.

Preferential-looking tests have been studied extensively in preverbal and verbal children as a means for testing visual acuity.¹⁻³ The Teller Acuity Card Test assumes that an individual able to resolve an image on one side of a card will look toward that side.³ Grating stimuli of progressively higher spatial frequency (i.e., finer width, which makes them harder to see) are presented until the individual being tested no longer demonstrates a preference for looking at one side over another.

Studies have shown that grating visual acuity measured with preferential-looking techniques correlates well with visual acuity measured using letter or symbol charts in pediatric patients, although grating acuities were found to exceed letter acuity in older children with amblyopia.⁴ One study of 12 nursing home residents reported that when the subjects were retested, all measures were within half an octave of each other, both with the same observer and with two observers.⁶ A second study in a small sample by the same authors found similar results when grating acuity and Sloan near cards were used when testing noncommunicative nursing home residents.⁷

Testing visual acuity with gratings could offer significant advantages for adults with cognitive impairment who cannot reliably respond to standard letter or symbol charts. We tested nursing home residents participating in a clinical trial of visual impairment intervention with both standard recognition acuity and grating acuity based on preferential looking. We report on the ability of nursing home residents to be tested with the two approaches, the degree of concordance of results of the two tests, and the factors that influence those results.

METHODS

The Salisbury Eye Evaluation in Nursing Home Groups (SEEING) project is a randomized clinical trial in which nursing home residents are assigned to either intensive visual rehabilitation and low-vision services or usual care, to determine the impact of this intervention on quality of life. The study is being conducted in 28 nursing homes on Maryland’s Eastern Shore and in Delaware. The data presented herein are from the first 11 nursing homes enrolled.

Subjects are eligible to be in the SEEING study if they are 65 years of age or older and have a life expectancy of more than 6 months. Residents in the nursing home for a short stay (less than 30 days), those who were determined by nursing home staff and the SEEING team members to be completely unable to perform visual acuity testing in either eye due to unresponsiveness, those who were too ill to be tested, and those unable to give informed consent and for whom no guardian was assigned were ineligible. The Johns Hopkins Institutional Review Board, in accordance with the Declaration of Helsinki, approved the study protocol. All studied subjects gave informed consent, or their legal guardians provided informed consent.

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Visual Acuity Testing

All visual acuity measurements were made both as the subject presented (with the patient’s habitual distance correction) and after refraction. Refraction was only performed in patients with acuity in the better-seeing eye of less than 20/40 at initial examination. All individuals were tested first with Early Treatment Diabetic Retinopathy Study (ETDRS) charts or Lea symbols to determine whether refraction was necessary. Different technicians administered the recognition (ETDRS or Lea symbols) and grating acuity tests, with the grating acuity technician masked to the results of recognition acuity testing. All staff conducting visual acuity testing underwent training and certification before the start of the study. When necessary, subjects were given a rest between tests, with a third of subjects tested on separate days. The test–retest reproducibility in 32 eyes of 18 patients was 0.97 for grating acuity and 0.98 for recognition testing (intraclass correlation coefficient (ICC)) on patients tested at baseline and 1 week later. Subjects for this validity testing were selected by randomly pulling charts of subjects for retesting at two nursing homes. The MiniMental Status Examination (MMSE) scores in this group were 15.6 ± 6.9 (SD), slightly higher than the overall mean for the study group.

Letter or Symbol Acuity

An ETDRS light box with Bailey-Lovie charts was placed 3 m from the participant. For patients tested in their rooms, a 2-m testing distance was used. The luminance of the box was measured with a spot photometer (model CS-100; Minolta, Ramsey, NJ), and the light box was calibrated at 130 to 150 cd/m². The left eye was patched, and the acuity was measured in the right eye first. The participant was instructed to read the first letter in each row while the operator pointed at the letters. Participants who hesitated or gave wrong answers were asked to read all the letters on the line. If any letters were missed, subjects were asked to read the previous line. Subjects read one row at a time until four of five letters on a line were missed. The total number of correct letters read was recorded to determine the log minimum angle of resolution (logMAR) visual acuity. If the subject was illiterate or could not respond to letters, a Lea symbol chart was used (~1/10 subjects).6 Patients were allowed to point to a sample set of symbols to match with the symbol on the chart if this improved the communication of responses.

If a subject could not read the first letter on the chart, then the chart was moved to 2 m and then to 1 m. The lowest score obtainable with an ETDRS or Lea symbol chart was being able to read one letter at 1 m or an equivalent visual acuity of 20/960 (1.68 logMAR units). For purposes of this study, persons with visual acuity rated as count fingers, light perception, and no light perception were all treated as severely impaired and were assigned a visual acuity of 1.70 logMAR units (34 individuals).

Grating Acuity

Teller acuity cards with high-contrast (83%), black-and-white square-wave gratings were used.13 Cards are one-half an octave apart (0.15 logMAR). Visual acuity is taken as the visual angle of the square-wave grating in minutes of arc. Lighting conditions were tested every time the room lights were turned on or off, before patients were examined. Gooseneck lights were aligned adjacent to the subject so that they illuminated the screen directly without producing glare. The illumination of the screen was set within 400 to 500 lux (equivalent luminance of 130–160 cd/m²) before visual acuity testing started, to ensure that grating and letter or symbol acuities were tested under similar lighting conditions. The distance from the patient’s eye to the front edge of the screen was 84 cm. The left eye was covered with a patch, and the right eye was tested first. The subject was instructed to look in the direction of the stripes on the card and was allowed to point in that direction, although the tester relied on preferential looking to determine a seeing response. Each card was presented to the subject a minimum of two times, and the subject had to correctly identify the side with the stripes on two of three presentations. The technician did not know which side had the grating target when presenting the card. The technician observed the patient through a central hole in the card immediately after presenting the card to the patient.

Testing was started with the low-vision card to observe the way in which the subject responded to obviously present stripes. Subjects who could not see the stripes on the low-vision card were moved closer to the screen and retested until they were at a distance of 19 cm from the screen. Subjects who could see the low-vision card were presented a card with no grating stimulus so that the operator could witness a nonresponse.

In patients who could see the low-vision card, testing was started with a 2.3-cyc/cm card (20/1400). If the patient saw this card on two of three attempts, then the operator skipped a card and presented the 4.8-cyc/cm card, continuing in two-card steps until the subject failed on one try. Subjects who failed once were presented with the intermediate card (in this case the 3.2-cyc/cm card). The last card on which the subject saw two of three presentations was recorded as the final visual acuity. If the subject exhibited a nonseeing response on two of three presentations, the operator ended the test and credited the patient with seeing the last card on which two of three presentations were perceived.

Differences in Acuity-Testing Strategies

Grating acuity testing differs from letter acuity testing in three important ways: (1) Grating acuity testing ends when the tester determines that the subject has exhibited a nonseeing response to a card or when the subject’s seeing response is incorrect on two of three attempts; (2) cards are spaced one-half octave apart (which is equivalent to 1.5 lines on the recognition acuity chart) while recognition acuity is measured to the exact number of letters read on the last line on which fewer than three letters were missed when using a forced-choice procedure. Grating acuity is therefore not as precise as recognition acuity; and (3) gratings are all vertical, whereas letter stimuli require resolution at different orientations. Thus, gratings are selectively sensitive to un- or undercorrected astigmatic refractive errors that have greater power in the horizontal meridian. Refraction, including retinoscopy, was performed in all persons with acuity worse than 20/40.

MiniMental Status Examination

The standard MMSE was administered to all participants.9 All 20 questions were asked, adhering strictly to protocol. Scores could range from 0 (if the subject did not respond correctly to any of the questions) to 30 (a perfect score on all questions that were attempted). A score less than 18 is considered severe cognitive impairment. If a subject could not complete a task because of a physical limitation (e.g., blindness would preclude answering a question requiring sight), then the question was scored as not applicable, and the final MMSE score was calculated with an adjustment to account for the removal of the question.

Statistics

Initial examination acuity and best corrected acuity (for both letters or symbols and grating stimuli) were defined according to the acuity score in the right eye. Data from the left eye were used when no right eye data were available (9 subjects), or from both eyes when subjects could only be tested with both eyes open (15 subjects). Three individuals who were testable by both methods were excluded from comparisons of acuities obtained. Two of these individuals were testable in different eyes by Teller and recognition acuity charts, and one individual was testable in one eye only with the recognition acuity chart, but had to be tested bilaterally with the Teller cards.

The correlation statistics we used are reasonable summary measures of how strongly grating acuity and recognition acuity relate to one another. However, they do not fully elucidate overall or selective biases in one measure relative to the other. Therefore, we applied the Bland-Altman method to achieve the latter goal.20 Specifically, we plotted the difference in a person’s two acuity measurements (grating
Table 1. Characteristics of the Eligible Population by Participation Status

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Participants (n = 656)</th>
<th>Eligible Nonparticipants (n = 334)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y, mean ± SD)</td>
<td>83.4 ± 8.3</td>
<td>84.4 ± 7.9</td>
</tr>
<tr>
<td>Race (% black)</td>
<td>22.7</td>
<td>16.8*</td>
</tr>
<tr>
<td>Sex (% female)</td>
<td>75.0</td>
<td>75.5</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% &lt;High school</td>
<td>76.7</td>
<td>69.2</td>
</tr>
<tr>
<td>% ≥High school</td>
<td>12.8</td>
<td>14.1</td>
</tr>
<tr>
<td>% Not available</td>
<td>10.5</td>
<td>16.7*</td>
</tr>
<tr>
<td>Length of stay (mo, mean ± SD)</td>
<td>35.9 ± 54.9</td>
<td>34.2 ± 34.0</td>
</tr>
<tr>
<td>MMSE score (mean ± SD)</td>
<td>12.8 ± 8.8</td>
<td>NA</td>
</tr>
</tbody>
</table>

* P < 0.05.

Of those, 656 (67%) consented to have visual acuity tested, of whom 90 (13.6%) could not be tested with either the recognition acuity chart or Teller cards. The remaining 566 individuals who consented to participate in the study were testable in at least one eye with either or both methods. Three individuals who were thought to perceive no letters on recognition acuity tests but were testable with Teller cards were assumed to be untestable with the recognition acuity chart.

The 656 residents who consented to participate in the study had a mean age of 83.4 years; 75% were female and 22.7% were black (Table 1). The mean MMSE score of the 566 individuals in whom visual acuity testing was possible was 14.5 ± 8.0. Participants did not differ from eligible nonparticipants with regard to age, sex, education, and length of stay in the nursing home. African Americans were more likely to agree to participate (22.7% of participants were African Americans compared with 16.8% of nonparticipants, P = 0.04). In the multivariate model, when adjusting for age and sex, African Americans remained more likely to participate, but this was of borderline significance (P = 0.05).

Results

Of the 1467 individuals 65 years of age or more, 990 (67.5%) satisfied eligibility criteria and were approached for the study.

Table 2. Characteristics of Study Participants by Testability

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Untestable (n = 90)</th>
<th>Testable by Recognition Only (n = 12)</th>
<th>Testable by Recognition and Teller (n = 468)</th>
<th>Testable by Teller Only (n = 86)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y, mean ± SD)</td>
<td>83.0 ± 7.8</td>
<td>83.5 ± 8.8</td>
<td>83.5 ± 8.2</td>
<td>83.1 ± 9.0</td>
</tr>
<tr>
<td>Race (% black)</td>
<td>16.7</td>
<td>33.3</td>
<td>22.7</td>
<td>27.9</td>
</tr>
<tr>
<td>Sex (% female)</td>
<td>71.1</td>
<td>75.0</td>
<td>75.2</td>
<td>77.9</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% &lt;High school</td>
<td>73.3</td>
<td>75.0</td>
<td>77.6</td>
<td>75.6</td>
</tr>
<tr>
<td>% ≥High school</td>
<td>14.4</td>
<td>16.7</td>
<td>11.5</td>
<td>17.4</td>
</tr>
<tr>
<td>% Not available</td>
<td>12.3</td>
<td>8.3</td>
<td>10.9</td>
<td>7.0</td>
</tr>
<tr>
<td>Length of stay (mo, mean ± SD)</td>
<td>36.0 ± 35.1</td>
<td>45.8 ± 32.0</td>
<td>32.2 ± 35.2</td>
<td>54.1 ± 120.2</td>
</tr>
<tr>
<td>MMSE score (mean ± SD)</td>
<td>1.3 ± 3.2</td>
<td>4.8 ± 5.7</td>
<td>16.2 ± 7.2</td>
<td>6.8 ± 7.2*</td>
</tr>
<tr>
<td>Teller acuity at initial examination</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Worse than 20/40</td>
<td>NA</td>
<td>NA</td>
<td>53.9</td>
<td>76.7*</td>
</tr>
<tr>
<td>% Worse than 20/100</td>
<td>NA</td>
<td>NA</td>
<td>22.0</td>
<td>39.5*</td>
</tr>
<tr>
<td>ETDRS acuity at initial examination</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Worse than 20/40</td>
<td>NA</td>
<td>100.0</td>
<td>63.7</td>
<td>NA</td>
</tr>
<tr>
<td>% Worse than 20/100</td>
<td>NA</td>
<td>58.3</td>
<td>30.3</td>
<td>NA</td>
</tr>
</tbody>
</table>

* Significant difference (P < 0.05) from reference group (those testable by both recognition and grating methods).
was pronounced in the severely cognitively impaired: 61% of those with MMSE scores less than 10 could be tested with Teller cards versus 41% by recognition charts.

Teller and recognition acuity were both obtained in the same eye in 465 individuals and correlated strongly (ICC = 0.79). Correlation between the two tests was higher in those with MMSE scores of 18 or higher (ICC = 0.85) than in those with scores less than 18 (ICC = 0.75). Figure 1 shows the Bland-Altman plot in the bottom panel and the corresponding plot of grating versus recognition acuity in the top panel. Both plots reveal reasonable agreement for acuities of approximately 0.8 logMAR and better, but they show a clear tendency for recognition measures to indicate worse acuity than grating measures in the range of worse acuities. The corresponding ICC is 0.79 (95% CI, 0.75–0.98), strongly supporting failure of agreement in part of the range. Therefore, rather than test for overall bias, we proceeded to explore the nature of the disagreement. Figure 2 compares the results, when grating and recognition acuities were used in patients with varying levels of cognitive ability, as measured by the MMSE score. Those with lower MMSE scores had consistently lower scores on recognition acuity (versus grating acuity) than those with higher MMSE scores. The mean difference in acuity obtained using the two methods was 0.11 logMAR better acuity with Teller cards for those with MMSE less than 18 versus average 0.04 logMAR better acuity for those with MMSE 18 or more. Furthermore, 23 (12.4%) of 186 individuals with MMSE of 18 or higher (individuals with mild dementia) had grating acuity that was at least 0.3 logMAR better than letter acuity, as opposed to 62 (23%) of 274 with MMSE less than 18. When all 465 individuals testable by both methods are considered, 85 (18%) eyes testable by both grating acuity and recognition had at least 0.3 logMAR better grating acuity, whereas only 30 (6%) had better recognition acuity of this magnitude (Table 3).

To assess the importance of finding reduced vision when testing with the different methods, we calculated the rate of referral (by an ophthalmologist examining the resident) for the provision of spectacles, low-vision services, or cataract surgery for those found to have vision less than 20/40 bilaterally. Of the 165 individuals who were found to have visual acuity of less than 20/40 in both eyes, measured by both grating and recognition acuity, 145 (88%) were assigned to receive an intervention. Of the 66 individuals in whom recognition acuity was untestable but grating acuity was testable and less than 20/40 in both eyes, 56 (85%) were assigned to an intervention. Finally, 15 (94%) of the 16 individuals who had recognition acuity of less than 20/40 bilaterally but were untestable by grating acuity were assigned to a study intervention.

**DISCUSSION**

Testing vision in the current nursing home environment is difficult because of the high proportion of residents with severe cognitive loss. The average MMSE score for the residents in this study was 12.8%, with 15.2% of eligible individuals obtaining a score of 0 on the MMSE. More than 85% of eligible nursing home residents participating in this study were able to respond to visual acuity testing. A standard letter chart (ETDRS or Lea symbols) could be used in almost three quarters of individuals, including some with severe cognitive impairment. However, when preferential-looking methods were used to measure grating acuity, testability increased to almost 85%. This is an encouraging finding, given the high prevalence of dementia among the nursing home residents studied.

However, residents who were completely unresponsive were excluded from the study. Sixty-two were ineligible for vision testing because of extremely poor cognitive status and were therefore never tested. Because these individuals were untestable with either technique, had they been included, the overall testability with the two approaches would have been reduced. Assuming that these residents would have participated at the same rate as the remainder of the cohort, overall testability with at least one eye testable by either procedure would have been 79%, grating acuity testability would have been 76%, and recognition acuity testability would have been 67%. Furthermore, residents with an MMSE score of less than 10 who were testable would have been 48% using Teller cards and 33% using ETDRS or Lea symbols. These data suggest that visual acuity screening can be attempted on most of the population in these homes, but that those with the greatest cognitive impairment are frequently untestable.

The average grating acuity measured with Teller cards was 0.08 logMAR (four letters) better than the average letter or symbol acuity measured with the recognition acuity charts (although median values were the same). Because 0.02 logMAR
credit was given for every letter read on the recognition acuity charts, whereas grating acuity steps were 0.15 logMAR, the bias introduced by differences in measurement precision should have favored letter acuity. There are five possible explanations for the finding of better acuity with grating testing: (1) The Teller cards consist of vertical stripes that are selectively insensitive to residual astigmatic refractive errors along the vertical axis, whereas residual astigmatism along the horizontal axis would blur both the gratings and the letters. This asymmetry in the effects of un- or undercorrected astigmatism would give better acuity results with Teller cards than with the recognition charts. (2) The gratings on the Teller cards produce luminance artifacts at their borders—that is, the grating ends abruptly at the gray background, and therefore the border can be visible, even if the grating is not. This artifact could be a stimulus to preferential looking in the direction of the grating, even when the grating itself is invisible. There is no way to quantify the importance of this effect, which would require the resident to look outside the center of the square where the gratings typically appear. (3) The fixed size of the Teller cards causes probability summation to increase with more difficult stimuli. The window that contains the grating on the Teller cards is a fixed size (12.5 × 12.5 cm). As spatial frequency increases, the number of cycles per grating increases proportionally. Previous research has shown that contrast sensitivity and visual acuity (frequency with a contrast threshold of 1.0) increase with the number of cycles presented. This dependence of grating acuity on the number of cycles is explained by probability summation (i.e., the patient gets multiple looks at the stimulus). Teller cards could be improved by using gratings that are multiplied by a Gaussian contrast window (contrast gradually feathers from 100% to 0% at the margins of the window) that is scaled to the spatial frequency of the grating (i.e., the size of the window is inversely proportional to the spatial frequency, so that there is a constant number of cycles of the grating across spatial frequencies). The Gaussian window would eliminate concerns about probability summation, and it also would eliminate the luminance edge artifact in the Teller cards. (4) Teller acuity was tested at a closer distance than recognition acuity. This closer working distance may have increased the attentiveness of the study subjects and permitted them to complete acuity testing. (5) Preferential looking may be less tiring than recognition acuity testing. Simply having to look at the cards may have been easier for residents than having to name letters or symbols and resulted in less fatigue among the subjects.

The Bland-Altman analysis demonstrated that for those with an MMSE score of more than 18 the results for grating and recognition acuities were similar, whereas the results with grating acuity tended to be consistently better for those with lower MMSE. This both supports that the two measures have reasonable agreement properties and is consistent with a hypothesis that cognitively impaired individuals may perform poorly on recognition acuity, regardless of their visual abilities.

One additional explanation for higher grating acuity scores is the method of testing. When testing Teller acuity, we had the observer determine whether a seeing response was present. If so, the correct side of the card had to be seen on two of three presentations. It is possible that on some occasions a nonseeing response resulted in correct guesses, which would overestimate the acuity. Conversely, the observer may have inappropriately labeled a seeing response as a nonseeing response,
which would have underestimated the grating acuity. We believe that the standardized training and certification procedures used, as well as the consistent testing of the nonseeing response before beginning the testing of vision, makes the likelihood of either of these events fairly small.

Previous studies comparing grating acuity to letter or symbol recognition acuity in verbal children have also demonstrated good correlation between the two methods, but with a bias in favor of grating acuity in children with amblyopia. Kushner et al. point out, one additional factor that may explain why grating acuity tests overestimate visual acuity when compared with letter or symbol recognition tests is that it is more difficult to determine what a pattern is than to know that it is present. One study in which mentally handicapped inpatients were tested with both Snellen and Teller acuity found correlations similar to those obtained in the present study with no tendency toward better vision when the Teller cards were used. This may be due in part to the different cohort tested, or to the slightly different approach in which Teller acuity was obtained by using a staircase method. To our knowledge, no data have been published comparing grating and recognition acuity results in normal adults.

Some individuals had worse acuity when tested with Teller cards than when tested with recognition acuity charts. This may be explained in part by fatigue, because testing with the recognition acuity chart was always conducted before testing with Teller cards to obtain best correction. We noted early in the study that, occasionally, patients could not perform grating acuity after letter acuity because of exhaustion. We changed testing procedures at that time to allow a rest period between tests to minimize fatigue, and nearly one third of study subjects were tested on a separate day. Another important explanation is the fluctuation in cognition that many of these residents demonstrated.

Although the group mean and median acuities were similar with the two tests, there was a group of individuals in whom large differences occurred. Eighteen percent of those testable by both methods had measured acuities that were three or more lines different. The tendency was for grating acuity to be better than recognition acuity. Certainly, in some cases, these represent overestimates, but these often may represent cases in which cognitively impaired individuals were unable to complete recognition testing.

Although 33% of nursing home residents either refused participation or were discharged or died after they were identified as potential participants, the demographic makeup of these individuals was similar to that of those who were enrolled. It is unlikely that there would be a large enough difference between grating and recognition acuity in this group to change our results from the larger population studied. An additional strength of the study is the masking of the technicians who tested visual acuity. The technicians who performed visual acuity measurements with the Teller cards did not know the results of the acuity measurements made with the recognition acuity charts.

For grating acuity to be used as a screening measure in individuals unable to respond to standard visual acuity testing, it should identify those with loss of visual acuity caused by potentially treatable conditions. Assuming that the letter recognition acuity obtained in individuals with MMSE score of 18 or more is accepted as the gold standard for the visual acuity of these individuals, then measurements with Teller cards overestimated visual acuity by the equivalent of three or more lines in 1 of 10 of these individuals. Similarly, using a visual acuity cutoff of 20/40 to categorize an individual as needing further assessment in the group testable by both ETDRS and Teller cards, testing with the recognition acuity charts would have led to a 64% referral rate, whereas testing with the Teller cards would have led to a 54% referral rate.

Once an individual is labeled as untestable for cognitive reasons, it is unlikely that he or she will receive potentially vision-restoring care. By increasing the likelihood that such individuals can be tested, grating acuity measured with preferential-looking methods opens the opportunity to monitor and care for them. In fact, we found that 85% of those untestable by conventional recognition acuity who had bilateral visual acuity less than 20/40 were deemed by an examining ophthalmologist to qualify for vision rehabilitation interventions. Based on our findings, grating acuity testing appears to be useful in cognitively impaired individuals in whom standard letter or symbol recognition testing cannot be performed. In screening settings, we would use a cutoff of acuity worse than 20/40 as indicating impaired vision when using the Teller cards. Because our data indicate better visual acuity estimates using Teller cards, the 20/40 criterion will help to ensure that those with ocular disease, including cataract and refractive error, or those needing low-vision interventions are identified and treated appropriately.

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**References**


